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INTERNATIONAL STANDARD

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Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures –
Part 5: Resistance to earth

IEC 61557-5:2019-07 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

Part 5: Resistance to earth

FOREWORD

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International Standard IEC 61557-5 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This third edition cancels and replaces the second edition published in 2007. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) definitions and symbols in Clause 3 modified;
b) subclauses in Clause 4 restructured and aligned with other parts of the series;
c) limits for reduced voltages 25 V RMS or 35 V peak removed from 4.5;
d) requirements for clamps added;
e) marking for rated voltages to earth and measurement category added to Clause 5;
f) warning about absence of hazardous voltage added in Clause 5;
g) the term "percentage operating uncertainty" replaced by "operating uncertainty" in Clause 6;
h) equation for uncertainty corrected in Table 1;
i) new Annex A on test measurements with loop clamps added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
85/685/FDIS	85/696/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This International Standard is to be used in conjunction with IEC 61557-1:2019.

A list of all parts of the IEC 61557 series, published under the general title *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures*, can be found on the IEC website

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
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ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

Part 5: Resistance to earth

1 Scope

This part of IEC 61557 specifies the requirements ~~for~~ applicable to measuring equipment for measuring the resistance to earth using an AC voltage.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60364-6:2016, *Low voltage electrical installations – Part 6: Verification*

IEC 61010-1:~~2001~~2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016[1]

IEC 61010-2-030:2017, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits*

IEC 61010-2-032, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement*

IEC 61243-3, *Live working – Voltage detectors – Part 3: Two-pole low-voltage type*

IEC 61557-1:2019, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms, definitions and symbols given in IEC 61557-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

[1] A consolidated version of this publication exists, comprising IEC 61010-1:2010 and IEC 61010-1:2010/AMD1:2016.

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- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

~~**3.1**~~
~~**series interference voltage**~~
~~extraneous voltage superimposed on the measuring voltage~~

~~**3.2**~~
~~**auxiliary earth electrode**~~
~~additional earth electrode for a current required for the purpose of measurements~~

~~**3.4**~~
~~**probe**~~
~~additional earth electrode used as a probe for sampling potentials during measurements~~

3.1
resistance to earth
R_A
real part of the impedance to earth

Note 1 to entry: resistance to ground (US).

Note 2 to entry: IEC 60364-6 uses the term "earth resistance", which is considered to be the same.

[SOURCE: IEC 60050-195:1998, 195-01-18, modified – Notes 1 and 2 to entry and a symbol have been added.]

3.2
disturbance voltage
voltage produced between two points on two separate conductors by an electromagnetic disturbance, measured under specified conditions and superimposed on the measuring voltage

[SOURCE: IEC 60050-161:1990, 161-04-01, modified – in alignment with the use in this document; in addition, the deprecated term "interference voltage" has been deleted.]

3.3
earth electrode
conductive part, which may be embedded in a specific conductive medium, for example concrete or coke, in electric contact with the Earth

[SOURCE: IEC 60050-195:1998, 195-02-01, modified – The US variant, "ground electrode" has been omitted.]

3.4
earth electrode terminal
connection point for a probe connected to the earth electrode to be tested and that is used for the injection of the test current required for the purpose of measurement

Note 1 to entry: In accordance with the requirements of this document, earth electrode terminals are marked "E".

3.5
earth electrode probe terminal
connection point for a probe connected to the earth electrode to be tested and that is used as a voltage probe either connected direct to or nearest to the earth electrode for sampling potentials during measurement

Note 1 to entry: In accordance with the requirements of this document, earth electrode probe terminals are marked "ES".

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3.6
auxiliary earth electrode terminal
terminal for connection to an additional temporary earth electrode that is used for injection of a test current required for the purpose of measurements

Note 1 to entry: In accordance with the requirements of this document, auxiliary earth electrode terminals are marked "H".

3.7
auxiliary earth electrode resistance
R_H
resistance of an additional earth electrode ~~through which current flows that is required for the purpose of measurements~~

3.8
probe electrode terminal
additional temporary earth electrode used as a voltage probe for sampling potentials during measurements

Note 1 to entry: According to the requirements of this document, probe electrode terminals are marked "S".

3.9
probe electrode resistance
R_S
~~earth electrode~~ resistance of an additional earth electrode ~~used as a probe for sampling potentials during measurements~~

4 Requirements

~~The following requirements as well as those given in IEC 61557-1 shall apply.~~

4.1 General

In addition to the requirements of IEC 61557-1:2019, Clause 4, the requirements of Clause 4 of this document shall apply.

4.2 Output voltage

The output voltage present across the terminals E and H shall be an AC voltage ~~without a d.c. component~~.

~~The frequency and the waveform shall be chosen so that electrical interference, particularly from installations operating with system frequency, will not adversely influence the measurement result to an excessive degree.~~

~~**4.2** If the influence of interference voltages from distribution systems as a.c. currents or as d.c. currents exceeds the requirements of 4.3, this shall be stated by the manufacturer in the operating instructions.~~

~~**4.3** The maximum percentage operating uncertainty within the measurement range to be marked or stated shall not exceed ±30 % with the measured value as fiducial value, as determined in accordance with Table 1.~~

4.3 Disturbance voltage

Values of influencing voltages caused by AC or DC currents from distribution systems shall be stated by the manufacturer in the operating instructions and shall be used for the calculation in Table 1.

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4.4 Permissible resistance of probe and auxiliary earth electrode

The measuring equipment shall be capable of determining whether the maximum permissible resistances of the probes and auxiliary earth electrodes are exceeded.

4.5 Electrical safety

No hazardous touch voltages shall appear during the measurements. This can be achieved by a suitable design of the source for the output voltage by:

~~– limiting the open-circuit value of the output voltage to an r.m.s. value of 50 V or a peak value of 70 V;~~

~~NOTE The open-circuit voltage during measurements in agricultural plants should not exceed an r.m.s. value of 25 V or a peak value of 35 V.~~

~~– limiting the r.m.s. (peak) value of the short-circuit current to 3,5 mA (5 mA) when the value of the voltage exceeds 50 V (70 V) or 25 V (35 V).~~

~~When no compliance with the above condition exists, then an automatic disconnection of the measurement process shall operate within a time period permissible according to Figure 1 of IEC 61010-1.~~

– limiting the open-circuit value of the output voltage to 50 V AC RMS or 70 V peak;

– or, limiting the short-circuit output current to 3,5 mA AC RMS or 5 mA peak in the event that the output voltage value could exceed U_L;

– if the output voltage source does not comply with either of the above requirements, automatic disconnection of the output voltage source shall operate within a permissible time period, in accordance with IEC 61010-1:2010/AMD1:2016, Figure 2.

Terminals shall be rated for voltages less than or equal to 50 V or, at the minimum, for a working voltage equal to the nominal voltage of the distribution system and measurement category II in accordance with IEC 61010-2-030.

In the event of ratings less than or equal to 50 V, a warning shall be given in the operating instructions to check the absence of hazardous voltage on the earthing system with a two-pole low-voltage detector according to IEC 61243-3.

Test leads and accessories in accordance with IEC 61010-031, except for earth spikes/rods, shall, at the minimum, correspond to the rating of the terminals.

~~**4.6** The user shall not be exposed to a voltage exceeding the permissible touch voltage and the measuring equipment shall recover within specification, when any plug or socket of the measuring equipment, intended for connection to the distribution system's power supply is connected to 120 % of its nominal voltage. Protective devices shall not be activated.~~

4.6 Clamps intended to measure earth loop resistances according to IEC 60364-6:2016, Annex C, Clause C.3

Clamps intended to measure the earth loop resistance in accordance with IEC 60364-6:2016, Annex C, Clause C.3, whether attached to the instrument or stand alone, shall be specified according to IEC 61010-2-032 as Type A or Type B.

If specified for Type A, the rating shall, at a minimum, be for measurement category II.

If specified for Type B, the rating shall, at a minimum, be for measurement category II and a warning shall be given in the operating instructions to check in advance the absence of hazardous voltages on the earthing system with voltage testers according to IEC 61243-3.

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5 Marking and operating instructions

5.1 Marking

In addition to ~~the marking in accordance with~~ IEC 61557-1:2019, 5.1 and 5.2, the following information shall be provided on the measuring equipment:

- measurement range within which the maximum operating uncertainty applies;
- frequency of the output voltage;
- ~~Designation~~ name of the terminals (if applicable):
  - E: terminal for the earth electrode;
  - ES: terminal for the probe electrode placed nearest to the earth electrode;
  - S: terminal for the probe electrode;
  - H: terminal for the auxiliary earth electrode;
- marking for terminals H, S, E and ES according to the requirements of 4.5;
- rated voltage to earth or measuring category and maximum voltage to earth followed by the symbol according to IEC 61010-1:2010, Table 1, symbol 12.

5.2 Operating instructions

~~The operating instructions shall state the following in addition to the statements in IEC 61557-1.~~

~~**5.2.1** The range of applications (e.g. for agricultural plants or others) for the equipment for measuring earth resistance.~~

~~**5.2.2** If applicable, the influence of series interference voltages that are larger than the values stated under 4.3.~~

~~**5.2.3** A statement relating to the correct operation of the hand-driven generator (if provided).~~

~~**5.2.4** The designations of terminals when different from 5.1.3.~~

In addition to IEC 61557-1:2019, 5.3, the following information shall be provided in the operating instructions:

- the range of applications (e.g. for industrial plants or others) for the equipment for measuring resistance to earth;
- the influence of series disturbance voltages that are larger than the values stated in 4.3, if applicable;
- a statement relating to the correct operation of the hand-driven generator (if provided);
- the designations of terminals when different from those specified in 5.1;
- if applicable, a warning shall be given in the operating instructions that in the case of Type B clamps the absence of hazardous voltages on the earthing system shall be checked with two-pole low-voltage detector according to IEC 61243-3.

6 Tests

6.1 General

In addition to IEC 61557-1:2019, Clause 6, the following tests shall be ~~executed~~ performed.

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6.2 Operating uncertainty

The maximum operating uncertainty within the measurement range to be marked or stated shall ~~be~~ not exceed ±30 % with the measured value as fiducial value, as determined in accordance with Table 1~~. In this process, the intrinsic uncertainty shall be determined~~ under the following reference conditions:

– nominal value of the supply voltage;

– nominal ~~r.p.m.~~ r/min of the hand-driven generator when used as a supply;

– nominal frequency of the power supply in the case of mains-operated measuring equipment according to ~~4.3~~ 6.2;

– reference temperature 23 °C ± 2 °C;

– reference position in accordance with the manufacturer's statement;

– resistances of probes and auxiliary earth electrodes at least 100 Ω;

~~– interference voltage 0 V.~~

– disturbance voltage less than 1 V.

~~The operating uncertainty thus evaluated shall not exceed the limits specified in 4.3.~~

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Table 1 – Calculation of operating uncertainty

Intrinsic uncertainty or influence quantity	Reference conditions or specified operating range	Designation code	Requirements or test in accordance with the relevant parts of IEC 61557	Type of test
Intrinsic uncertainty	Reference conditions	A	~~Part 5, subclause 6.1~~ IEC 61557-5:2019 6.2	R
Position	Reference position ±90° approximately	E_1	~~Part 1, subclause 4.2~~ IEC 61557-1:2019, 4.2	R
Supply voltage	At the limits stated by the manufacturer	E_2	~~Part 1, subclauses 4.2, 4.3~~ IEC 61557-1:2019, 4.2, 4.3	R
Temperature	0 °C and 35 °C (± 2°)	E_3	~~Part 1, subclause 4.2~~ IEC 61557-1:2019, 4.2	T
Series ~~interference~~ disturbance voltage	See ~~4.2 and~~ 4.3	E_4	~~Part 5, subclauses 4.2, 4.3~~ IEC 61557-5:2019, 4.3	T
Resistance of the probes and auxiliary earth electrodes	0 R_A to 100 ~~×~~ R_A but ≤ 50 kΩ as defined by the manufacturer	E_5	~~Part 5, subclause 4.3~~ IEC 61557-5:2019, 6.2	T
System frequency	between 99 % and 101 % of the nominal frequency	E_7	~~Part 5, subclause 4.3~~ IEC 61557-5:2019, 6.2	T
System voltage	between 85 % and 110 % of the nominal voltage	E_8	~~Part 5, subclause 4.3~~ IEC 61557-5:2019, 6.2	T
Operating uncertainty	$B = \pm\sqrt{A^2 + \frac{4}{3}\sum_i E_i^2}$		~~Part 5, subclause 4.3~~ IEC 61557-5:2019, 6.2	R

Key

A = intrinsic uncertainty

~~E_n~~ E_i = variations

$$B\,[\%] = \pm\frac{B}{F} \times 100\ \%$$

R = routine test

T = type test

F = fiducial value

The operating uncertainty shall apply under the rated operating conditions given in IEC 61557-1 and the following:

– injection of series ~~interference~~ disturbance voltages with system frequencies of 400 Hz, 60 Hz, 50 Hz, 16 $^2/_3$ Hz (± 5 %) or with DC voltage respectively across the terminals E (ES) and S or to the earth resistance loop. The RMS value of the series ~~interference~~ disturbance voltage for equipment with auxiliary probes shall be 3 V (± 5 %);

– for equipment using current clamps, the presence of interfering disturbances shall be clearly indicated if the influence quantity ~~will~~ exceeds the specified value of the variation E_4 and of the operating uncertainty. An example of a test configuration for injection of the series disturbance voltages can be found in Annex A;

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